

What is claimed is:

1                   1.     A device for photodynamic stimulation of human cells, comprising:  
2                   a base housing containing a control mechanism and a pulse generator; and  
3                   at least one applicator equipped with at least one pulsed first light source connected to said  
4 pulse generator;

5 wherein:

6                   the generator is configured to selectably supply electrical pulses at a frequency between  
7 200 and 20,000 Hz., a pulse length between 2 and 200 microseconds, and an amplitude of  
8 between 2 and 25 volts; and

9                   the at least one first light source is a semiconductor diode which emits light of  
10 approximately 600, 900, and 1200 nanometers wavelength in response to said pulses from said  
11 generator.

1                   2.     A device according to claim 1, wherein at least one of the first light  
2 sources is a semiconductor diode which emits blue-light radiation in the range of 350 to 500  
3 nanometers.

1                   3.     A device according to claim 1, wherein at least one of the first light  
2 sources is a tube which emits blue-light radiation in the range of 350 to 500 nanometers.

1                   4.     A device according to claim 1, wherein the at least one applicator  
2 comprises sensors connected to the control mechanism for measurement of reflected light for  
3 feedback control and automatic adjustment.



1                   5.       A device according to claim 1, wherein the at least one applicator is  
2       mounted to the base housing by means of a movable-joint arm.

1                   6.       A device according to claim 5, wherein the at least one applicator  
2       comprises several single applicators hinged together so as to be adjustable at angles with respect  
3       to one another.

1                   7.       A device according to claim 1, further comprising a hand-held applicator  
2       comprising at least one second light source connected to said pulse generator and at least one light  
3       outlet.

1                   8.       A device according claim 7 wherein the hand-held applicator is equipped with a  
2       shaft and a head and a printed circuit board equipped with semiconductor diodes.

1                   9.       A device according to claim 7 wherein the at least one light outlet is equipped  
2       with a mounted lens.

1           10. A device according to claim 8 wherein:

2           at least a first semiconductor diode on the printed circuit board radiates red and infrared  
3 light at wavelengths of approximately 600, 900, and 1200 nanometers;

4           at least a second semiconductor diode on the printed circuit board radiates blue light in the  
5 range of approximately 350 to 500 nanometers;

6           the head comprises an expander rotatable to selectably conduct blue light or red and  
7 infrared light to said at least one light outlet.

8           11. A device according to claim 10, wherein the expander includes a fiber optic  
9 cable.

1           12     A device according to claim 10, wherein the light output is at  
2 approximately 25% of a selected level for approximately 10 seconds and is at the selected level  
3 thereafter.

1                   13.    A method of treating tissue, comprising the steps of:  
2                                   introducing a photosensitive substance to the tissue;  
3                   determining when the tissue has absorbed a predetermined level of the photosensitive  
4                   substance; and  
5                   irradiating the tissue with a device according to claim 1.

1                   14.    A method according to claim 13, wherein the step of introducing a  
2                   photosensitive substance to the tissue comprises topical application of a lotion containing the  
3                   photosensitive substance.

1                   15.    A method according to claim 13, wherein the step of introducing a  
2                   photosensitive substance to the tissue comprises oral ingestion of a substance comprising at least  
3                   the photosensitive substance.

1                   16. A method according to claim 13, wherein the step of introducing a  
2                   photosensitive substance to the tissue comprises subcutaneous injection of a substance comprising  
3                   at least the photosensitive substance.

1                   17. A method according to claim 13, wherein the photosensitive substance is one  
2                   of photofrin, 5-aminolevulanic acid, hematoporphyrin, verteporfin, chlorins, phthalodicyanines,  
3                   phenothiazine, benzoporphyrin-derivative monoacid-A (ATMPn), L-Phenylalanine, and ammi  
4                   visnaga.

1 18. A method according to claim 13, wherein dimethylsulfoxide is also introduced  
2 to the tissue.

1 19. A method according to claim 13, wherein dimethylsulfoxide is mixed with the  
2 photodynamic substance.

1 20. A method according to claim 13, wherein:  
2 the photosensitive substance is photofrin;  
3 the photosensitive substance is introduced to the tissue of a patient by subcutaneous  
4 injection of 1 to 2 mg. per kg. of the patient's weight;  
5 the patient is kept in dim light for approximately 48 hours before irradiation; and  
6 the patient is kept out of strong light for approximately eight weeks after irradiation.

1 21. A method according to claim 13, wherein:  
2 the photosensitive substance is 5-Aminolavulin acid;  
3 the photosensitive substance is introduced to the tissue of a patient by topical application of  
4 a 10 to 20 percent mixture in one of an oil-in-water emulsion and a cream;  
5 the patient is kept in dim light for approximately six hours before irradiation; and  
6 the patient is kept out of strong light for approximately 48 hours after irradiation.

1                   22. A method according to claim 13, wherein:  
2                   the photosensitive substance is L-Phenylalanin;  
3                   the photosensitive substance is introduced to the tissue of a patient by topical application of  
4 a 5 to 30 percent mixture according to a degree of treatment desired; and  
5                   the patient is kept out of strong light for approximately 24 hours after application.

1                   23. A method according to claim 13, wherein:  
2                   the photosensitive substance is L-Phenylalanin;  
3                   the photosensitive substance is introduced to the tissue of a patient by oral ingestion of 50  
4 to 100 mg according to the patient's weight and to degree of treatment desired;  
5                   the patient is kept in dim light for approximately 60 minutes before irradiation; and  
6                   the patient is kept out of strong light for approximately 24 hours after application.

1                   24. A method according to claim 13, wherein:  
2                   the photosensitive substance is ammi visnaga;  
3                   the photosensitive substance is administered to the tissue of a patient by topical application  
4 of a 5 to 30 percent mixture, according to degree of treatment desired, in a liquid medium;  
5                   the patient avoids direct sunlight for approximately 30 minutes before irradiation; and  
6                   the patient avoids sunbathing for approximately five days after irradiation.

1                   25. A method according to claim 13, wherein:

2                   the photosensitive substance is ammi visnaga;

3                   the photosensitive substance is administered to the tissue of a patient by oral ingestion of  
4 approximately 100 mg. thereof;

5                   the patient avoids direct sunlight for approximately three hours before irradiation; and

6                   the patient avoids sunbathing for approximately five days after irradiation.

1                   26. A method according to claim 13, wherein the step of determining when the

2 tissue has absorbed a predetermined level of the photosensitive substance comprises observing that  
3 the tissue undergoes a predetermined color change when viewed under a predetermined  
4 illumination.

1                   27. A method according to claim 26, wherein the predetermined illumination

2 comprises a wood lamp.

1                   28. An apparatus according to claim 1, wherein the pulse duration is limited to 20

2 microseconds.

1                   29. A method according to claim 13, wherein the pulse duration is limited to 20

2 microseconds.

30. A device for photodynamic stimulation of human cells, comprising:  
a base housing containing a control mechanism and a pulse generator; and  
at least one applicator equipped with at least one pulsed first light source connected to said  
pulse generator;  
wherein:  
the generator is configured to selectably supply electrical pulses at a frequency between  
200 and 20,000 Hz., a pulse length between 2 and 200 nanoseconds, and an amplitude of between  
40 and 400 volts; and  
the at least one first light source is a laser diode which emits light of approximately 600,  
900, and 1200 nanometers wavelength in response to said pulses from said generator.

31. A device according to claim 30, wherein at least one of the first light  
sources is a laser diode which emits blue-light radiation in the range of 350 to 500 nanometers.

32. A device according to claim 30, wherein at least one of the first light  
sources is a tube which emits blue-light radiation in the range of 350 to 500 nanometers.

33. A device according to claim 30, wherein the at least one applicator  
comprises sensors connected to the control mechanism for measurement of reflected light for  
feedback control and automatic adjustment.

34. A device according to claim 30, wherein the at least one applicator is  
mounted to the base housing by means of a movable-joint arm.



1                   35.     A device according to claim 34, wherein the at least one applicator  
2 comprises several single applicators hinged together so as to be adjustable at angles with respect  
3 to one another.

1                   36.     A device according to claim 30, further comprising a hand-held applicator  
2 comprising at least one second light source connected to said pulse generator and at least one light  
3 outlet.

1                   37.     A device according claim 36 wherein the hand-held applicator is equipped  
2 with a shaft and a head and a printed circuit board equipped with laser diodes.

1                   38.     A device according to claim 36 wherein the at least one light outlet is  
2 equipped with a mounted lens.

1                   39. A device according to claim 37 wherein:

2                   at least a first laser diode on the printed circuit board radiates red and infrared light at  
3 wavelengths of approximately 600, 900, and 1200 nanometers;

4                   at least a second laser diode on the printed circuit board radiates blue light in the range of  
5 approximately 350 to 500 nanometers;

6                   the head comprises an expander rotatable to selectably conduct blue light or red and  
7 infrared light to said at least one light outlet.

8                   40. A device according to claim 39, wherein the expander includes a fiber optic  
9 cable.

1                   41       A device according to claim 39, wherein the light output is at  
2 approximately 25% of a selected level for approximately 10 seconds and is at the selected level  
3 thereafter.

1                   42.     A method of treating tissue, comprising the steps of:  
2                   introducing a photosensitive substance to the tissue;  
3                   determining when the tissue has absorbed a predetermined level of the photosensitive  
4                   substance; and  
5                   irradiating the tissue with a device according to claim 30.

1                   43.     A method according to claim 42, wherein the step of introducing a  
2                   photosensitive substance to the tissue comprises topical application of a lotion containing the  
3                   photosensitive substance.

1                   44.     A method according to claim 42, wherein the step of introducing a  
2                   photosensitive substance to the tissue comprises oral ingestion of a substance comprising at least  
3                   the photosensitive substance.

1                   45.     A method according to claim 42, wherein the step of introducing a  
2                   photosensitive substance to the tissue comprises subcutaneous injection of a substance comprising  
3                   at least the photosensitive substance.

1                   46.     A method according to claim 42, wherein the photosensitive substance is one  
2                   of photofrin, 5-aminolevulanic acid, hematoporphyrin, verteporfin, chlorins, phthalodicyanines,  
3                   phenothiazine, benzoporphyrin-derivative monoacid-A (ATMPn), L-Phenylalanine, and ammi  
4                   visnaga.

1 47. A method according to claim 42, wherein dimethylsulfoxide is also introduced  
2 to the tissue.

1 48. A method according to claim 42, wherein dimethylsulfoxide is mixed with the  
2 photodynamic substance.

1 49. A method according to claim 42, wherein:  
2 the photosensitive substance is photofrin;  
3 the photosensitive substance is introduced to the tissue of a patient by subcutaneous  
4 injection of 1 to 2 mg. per kg. of the patient's weight;  
5 the patient is kept in dim light for approximately 48 hours before irradiation; and  
6 the patient is kept out of strong light for approximately eight weeks after irradiation.

1 50. A method according to claim 42, wherein:  
2 the photosensitive substance is 5-Aminolavulin acid;  
3 the photosensitive substance is introduced to the tissue of a patient by topical application of  
4 a 10 to 20 percent mixture in one of an oil-in-water emulsion and a cream;  
5 the patient is kept in dim light for approximately six hours before irradiation; and  
6 the patient is kept out of strong light for approximately 48 hours after irradiation.

1           51. A method according to claim 42, wherein:

2           the photosensitive substance is L-Phenylalanin;

3           the photosensitive substance is introduced to the tissue of a patient by topical application of  
4           a 5 to 30 percent mixture according to a degree of treatment desired; and  
5           the patient is kept out of strong light for approximately 24 hours after application.

1           52. A method according to claim 42, wherein:

2           the photosensitive substance is L-Phenylalanin;

3           the photosensitive substance is introduced to the tissue of a patient by oral ingestion of 50  
4           to 100 mg according to the patient's weight and to degree of treatment desired;  
5           the patient is kept in dim light for approximately 60 minutes before irradiation; and  
6           the patient is kept out of strong light for approximately 24 hours after application.

1           53. A method according to claim 42, wherein:

2           the photosensitive substance is ammi visnaga;

3           the photosensitive substance is administered to the tissue of a patient by topical application  
4           of a 5 to 30 percent mixture, according to degree of treatment desired, in a liquid medium;  
5           the patient avoids direct sunlight for approximately 30 minutes before irradiation; and  
6           the patient avoids sunbathing for approximately five days after irradiation.

1                   54. A method according to claim 42, wherein:  
2                   the photosensitive substance is ammi visnaga;  
3                   the photosensitive substance is administered to the tissue of a patient by oral ingestion of  
4 approximately 100 mg. thereof;  
5                   the patient avoids direct sunlight for approximately three hours before irradiation; and  
6                   the patient avoids sunbathing for approximately five days after irradiation.

1                   55. A method according to claim 42, wherein the step of determining when the  
2 tissue has absorbed a predetermined level of the photosensitive substance comprises observing that  
3 the tissue undergoes a predetermined color change when viewed under a predetermined  
4 illumination.

1                   56. A method according to claim 56, wherein the predetermined illumination  
2 comprises a wood lamp.

1                   57. An apparatus according to claim 30, wherein the pulse duration is limited to  
2 20 nanoseconds.

1                   58. A method according to claim 42, wherein the pulse duration is limited to 20  
2 nanoseconds.